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Testing the Value of Prickly Pear Cactus as a Nest-Predator Deterrent for Northern Bobwhite

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Recent research indicates that northern bobwhites (*Colinus virginianus*) in Texas commonly nest in prickly pear cactus (*Opuntia* sp.) instead of conventional bunchgrass habitat. We hypothesized that bobwhites nested in prickly pear because it served as a deterrent to nest predators thereby increasing probability of nest success (nest-protection hypothesis; Slater et al. 2001). We experimentally tested the nest-protection hypothesis by providing 50 wild-caught, captive raccoons (*Procyon lotor*) with combinations of simulated, bobwhite nests. Nest combinations included either 1 nest in bunchgrass (e.g., little bluestem [*Schizachryium scoparium*]) and 1 nest in prickly pear cactus (partial [75%] or full [100%] protection), or 2 separate nests in prickly pear (partial and full protection). Raccoons depredated 97%, 33%, and 14% of simulated nests constructed of bunchgrass (n = 35 nests), partial protection prickly pear (n = 30 nests), and full protection prickly pear (n = 35 nests), respectively. Prickly pear nests that provided full protection exhibited better survival against raccoon depredation than other nest types. Our study provides support for the nest-protection hypothesis regarding why northern bobwhite possibly nest in prickly pear cactus.

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Key words: cactus, *Colinus virginianus*, nest, northern bobwhite, predation, *Procyon lotor*, raccoon

Introduction

Northern bobwhites (*Colinus virginianus*) sustain a high incidence of nest failure, and depredation often is cited as the primary cause. To illustrate: Klimstra and Roseberry (1975) reported that, in Illinois, only 34% (n = 863 nests) were successful with predators accounting for 55% of nest failures; and in southern Texas, Lehmann (1984, p. 91) documented that 45% of 532 nests were successful, and depredation accounted for 84% of nest failures. In light of these high nest-depredation rates, researchers have speculated that nest depredation may be a limiting factor of bobwhite recruitment (Hurst et al. 1996, Rollins and Carroll 2001).

Probability of nest success can be influenced by various factors including nest location and nesting substrate. Research indicates that dense, residual cover can reduce nest depredation for various ground-nesting gamebirds (Schrank 1972, Kirsch 1974, Duebbert and Lokemoen 1976). Slater et al. (2001) documented that egg survival of simulated, bobwhite nests was proportionally related to density of potential bunchgrass nest sites. Martin and Roper (1988) hypothesized that predator efficiency decreased as the density of foliage surrounding the nest increased.

Bobwhites generally nest in bunchgrasses such as little bluestem (*Schizachyrium scoparium*) (Stoddard 1931, Klimstra and Roseberry 1975, Lehmann 1984, Peoples et al. 1996). However, in the southern Rolling Plains of Texas (Gould 1975), Carter et al. (2002) reported that 57% of bobwhite nests (n = 21) were located in prickly pear cactus (*Opuntia* spp.; hereafter, prickly pear) instead of traditional bunchgrass habitat. Hernandez et al. (2003) also reported that about 30% of bobwhites nests (n = 83) in this region were located in prickly pear despite adequate amounts of bunchgrass cover (>600 nest-

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ing sites/ha). More recently, Brooks (2005) provided further evidence of bobwhite nesting in prickly pear cactus in the Rolling Plains. Other instances of bobwhites exhibiting such a high use of prickly pear as nesting cover have not been reported in the literature (Lehmann 1984, p. 81). Slater et al. (2001) hypothesized that bobwhites were nesting in prickly pear because it provided mechanical protection against nest predators.

Given the recent documented use of prickly pear as nesting cover by bobwhites, we questioned why bobwhites used prickly pear as nesting cover. We developed a nest-protection hypothesis after Slater et al. (2001) and speculated that bobwhites nested in prickly pear because it provided nests structural protection against predators. The premise of the hypothesis is founded on the theory of natural selection, which implies that bobwhites will nest in areas that offer the greatest probability for success. Based on the nest-protection hypothesis, we predicted that survival of simulated, bobwhite nests would be higher for nests located in prickly pear than for nests located in bunchgrass.

Methods

We conducted an experiment to test the nest-protection hypothesis using 50 wild-captured, adult raccoons (Institutional Animal Care and Use Committee, Texas A&M University-Kingsville, No. 1-97-38). We captured adult raccoons in Kleberg County, Texas during October-December 1998. We selected raccoons as the nest predator because raccoons are considered to be the main predator of bobwhite nests in the Rolling Plains of Texas (Hernandez et al. 1997) where bobwhites have been documented to commonly use prickly pear as a nesting substrate.

We individually housed raccoons in kennels (1.2 m x 2.4 m x 2.2 m) and provided water and canned dog food *ad libitum* during a 2-3 day acclimation period. We then subjected each raccoon to 1 nest trial within their respective kennel. A nest trial presented raccoons with 2 simulated nests: either 1 nest in bunchgrass and 1 nest in prickly pear (partial or full protection), or 2 separate nests in prickly pear (partial and full protection). We used live prickly pear pads to construct a nest with either full protection or partial protection. Full protection was represented by 5 prickly pear pads that formed a cube around the nest with the ground representing the sixth side (Hernandez 1999). Thus, access to nests with full protection was obstructed by prickly pear pads from all angles. For partial protection, prickly pear pads formed 4 of the 5 sides of a cube, with the ground completing the cube (Hernandez 1999). Partial protection allowed access to nests from 1 side. To simulate a bobwhite nest in bunchgrass habitat, we cut and used bunchgrasses (e.g., little bluestem) to construct a nest bowl. All nests contained 1 chicken egg that was connected to a timer, which recorded the exact time of depredation (Hernandez 1999). We used a chicken egg instead of a quail egg because chicken eggs were readily available. We contend that using chicken eggs did not invalidate our study because once the protection afforded by the nesting substrate was breached, it is unlikely that egg size (chicken vs quail) would influence raccoon consumption of an egg in a captive setting.

We began nest trials at 1200 hrs and lasted for 24 hours. We withheld food, but not water, from the raccoons during the 24-hr period of the nest trial. We randomly assigned raccoons to nest trials. Twenty raccoons were used in nest trials consisting of simulated nests with full prickly pear protection and nests in bunchgrass. Fifteen raccoons were subjected to nest trials consisting of partial prickly pear protection and nests in bunchgrass. Lastly, 15 raccoons were used in nest trials consisting of 2 separate nests with full and partial prickly pear protection. We did not use in our nest trials raccoons that did not acclimate to the kennels (i.e., did not consume food or water during the acclimatization period). Our goal was to have at least 20 raccoons per nest trial, a logistically practical sample size given our captive facilities and the use of individual, wild-trapped raccoons for each nest trial. Unequal sample sizes arose because not all trapped raccoons acclimated to the captive facilities (e.g., too aggressive, never ate, etc.) and thus were not used in the trials.

We determined the depredation rank for each nest type by the order of depredation times. A nest type that was depredated first received a rank of 1; a nest type that was depredated second received a rank of 2; and a nest type that was not depredated within the 24-hr trial received a rank of 3. We used Kruskal-Wallis one-way analysis of variance by ranks test (Daniel 1987) to compare depredation ranks between prickly pear protection (full or partial) and bunchgrass nests, as well as between full protection and partial protection of prickly pear nests. We report all results as 0 $\pm$ SE and consider results significant at $\alpha = 0.05$.

Results

Nests in prickly pear with full protection survived for a longer period of time (0 survival category = 2.55 α 0.15) than nests in bunchgrass (0 survival category = 1.35 α 0.17; $P < 0.001$). Nests in prickly pear with full protection also survived longer (0 survival category = 2.53 α 0.16) than nests with partial protection (0 survival category = 1.45 α 0.21; $P = 0.0005$). However, there was no difference in survival time between nests in prickly pear with partial protection (0 survival category = 1.67 α 0.19) and nests in bunchgrass (0 survival category = 1.60 α 0.16; $P = 0.79$).

Considering nest survival for the entire study, 5 of 35 (14%) prickly pear nests with full protection were depredated during the trials compared to 10 of 30 (33%) prickly pear nests with partial protection. Thirty-four of 35 (97%) bunchgrass nests were depredated.

Discussion

The nest-protection hypothesis stated that nest success would be higher for nests located in prickly pear than for nests located in bunchgrass. Our data supported this prediction; nests with full protection were less vulnerable to raccoons than nests with partial or minimal protection. Our results were similar to Slater et al. (2001) who reported that simulated nests placed in prickly pear had a greater mean survival time than bunchgrass nests at sites with marginal nesting cover.

Our data suggest that prickly pear does not provide protection to nests in a binary manner, but rather the degree of protection appears to occur along a continuum. That is, the mere placement of nests in prickly pear does not guarantee protection against raccoons in an all or none manner, but rather protection spans between these 2 extremes depending on the degree of concealment. We documented that as degree of nest protection increased (from bunchgrass to partial to full protection), survival time of simulated nests also progressively increased. Hernandez et al. (2003) provided further evidence for such a trend under field conditions. They reported that 87% of bobwhite nests with full protection ($n = 15$) successfully hatched compared to 32% with partial protection ($n = 47$).

Although our data support the nest-protection hypothesis, we acknowledge that nest protection alone cannot explain why bobwhites are nesting in prickly pear. If nest fate depended solely on nest protection, then all bobwhites would be nesting in prickly pear because it represented the greatest probability for nest success during this simulated study. Naturally, this is not the case. Both Slater et al. (2001) and Hernandez et al. (2003) documented that nest fate was confounded with type of nesting substrate and surrounding bunchgrass density (i.e. overall nest concealment).

Hernandez et al. (2003) proposed that a new hypothesis that integrated the nest-protection hypothesis, and to a lesser extent a limited-bunchgrass hypothesis, could best explain why bobwhite nest in prickly pear. They reasoned that when bunchgrass cover became limited (e.g., following prescribed fire, overgrazing, or drought), prickly pear represented the most suitable nesting habitat (Soutiere and Bolen 1976, Carter et al. 2002). However, as bunchgrass cover increased, the probability of nest success equalized between prickly pear and bunchgrass habitat. Under these conditions, probability of nest success was similar between prickly pear and bunchgrass resulting in low or moderate use of prickly pear. However, this new hypothesis proposed by Hernandez et al. (2003) remains to be tested. A test of this new hypothesis could involve monitoring incidence of prickly pear use as a nesting substrate across along a continuum of study sites with increasing bunchgrass densities. Support for the hypothesis would detect an inverse relationship between prickly pear use and bunchgrass density as well as lower nest success for bunchgrass nests at lower bunchgrass densities but equal nest success between nest types (bunchgrass vs prickly pear) at higher bunchgrass densities.

We conclude that our study adequately supported the nest-protection hypothesis; however, it does not solely explain why bobwhites are nesting in prickly pear cactus.

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